NRC Sponsored Research at Universities

Division of Risk Assessment and Special Projects, Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission, Washington D.C.

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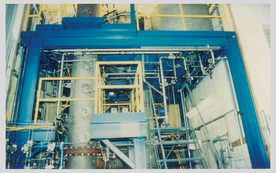
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Purdue University Multidimensional Integral Test Assembly (PUMA) - Purdue University

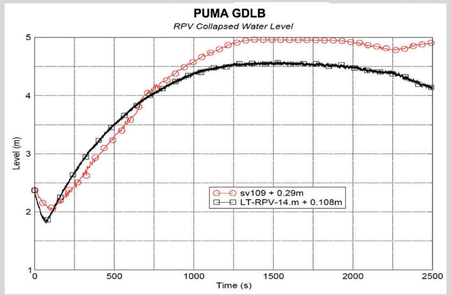
PUMA is a boiling water reactor (BWR) integral test facility that is designed to simulate all thermal-hydraulic phenomena that may occur during design basis accidents and other transients.

- ➢Generation of Well Scaled data for Advanced BWR Designs with Passive Safety Features
  - •Integral Test Data
  - •Separate Effects Test Data
- ➢Major Applications
  - •Design Certification of Advanced BWRs
  - •NRC Advanced Code (TRACE) Verification
  - •Evaluation of Beyond Design Basis Accidents
  - •Operational Transient Evaluation
  - •Start-up Transient (Nuclear Coupled Simulation)



PUMA Test Facility: Front and Top View

PUMA Integral Testing Compared to TRACE Code



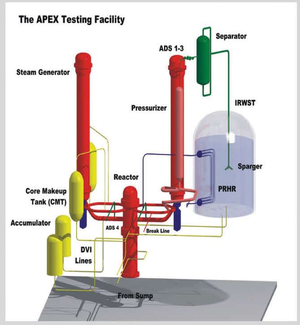
Advanced Passive Reactor Experiment Test Facility (APEX) - Oregon State University (OSU)

The APEX is a pressurized water reactor (PWR) integral test facility which was built to perform was built to perform AP600/AP1000 testing mainly for beyond-design-basis accident investigation.

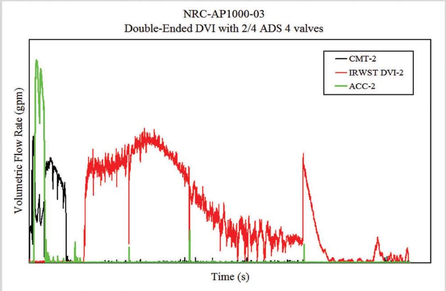
- ▪Facility Features:
  - ➢Scaled-down ratio relative to AP1000:
    - •Volume scale: 1/192
    - •Height/Length: ¼
  - ➢Operating pressure up to 400 psia.
  - ➢Core power up to 1 MW
  - ➢Includes all passive components of AP600 and AP1000

Currently a series of 5 separate effect tests are being conducted on reflux condensation in the steam generator. The test data obtained in the APEX steam generator will be used to assess the NRC's thermal hydraulic code, TRACE

APEX Test Facility



APEX-AP1000 Confirmatory Testing



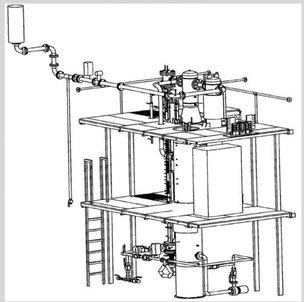
Rod Bundle Heat Transfer Test Facility (RBHT) - Pennsylvania State University (PSU)

The RBHT test program constructed a 7x7 rod bundle test facility and generated unique experimental data suitable for computer code model development and assessment for the analysis of loss-of-coolant-accidents (LOCAs).

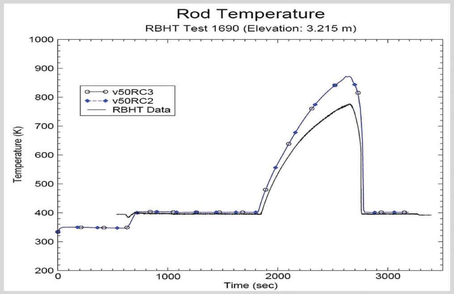
- ➢Generated Test Data
  - •33 reflood tests
  - •45+ interfacial drag tests
  - •20 steam cooling convective heat transfer tests without liquid droplet injection
  - •25 steam cooling tests with liquid droplet injection

RBHT test results include new and unique data on droplet break up and the local enhancement of heat transfer downstream of mixing vane spacer grids. Data from RBHT are being used to improve and assess thermal-hydraulic models in the TRACE code.

RBHT Schematic



RBHT Transient Uncovery Test Compared to TRACE Code



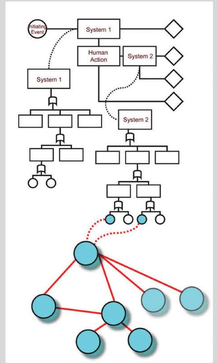
Cooperative Agreement University of Maryland (UMD)

The NRC and UMD cooperative agreement covers probabilistic risk assessment (PRA) techniques in risk-informed & performance-based regulations. The scope of the agreement includes:

- ▪Verification and Validation of Fire Models
  - ➢Assess the probability of fire-induced cable failure modes at nuclear power plants
- ▪Thermal-Hydraulic Uncertainty Analyses
  - ➢Develop a general thermal-hydraulics (TH) uncertainty analysis methodology to best estimate analyses by complex TH codes
  - ➢Treat uncertainties associated with the code's TH sub-models and their propagation through the code structure
- ▪Development of Formal Model Uncertainty Analysis Methods
  - ➢Develop a conceptual framework and methodology for treating PRA model and parameter uncertainties
  - ➢Demonstrate that many popular methods can be viewed as special cases of the general Bayesian framework

As part of the cooperative agreement, the NRC and UMD are also developing a nuclear engineering minor curriculum to facilitate knowledge management and transfer in nuclear safety & risk-informed regulation.

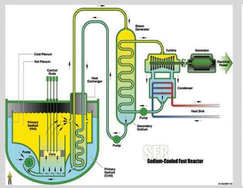
- ▪Four course undergraduate nuclear engineering minor sequence:
  - ➢Basic Nuclear Engineering
  - ➢Nuclear Reactor Systems and Safety
  - ➢Nuclear Technology Laboratory
  - ➢Capstone Design Project
- ▪Desired Outcomes:
  - ➢Provide students with basic elements of nuclear engineering in preparation for a career in industry or government
  - ➢Stimulate interest among undergraduate engineering students to initiate cooperative work assignments in the field of nuclear energy.

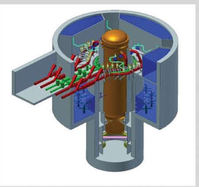


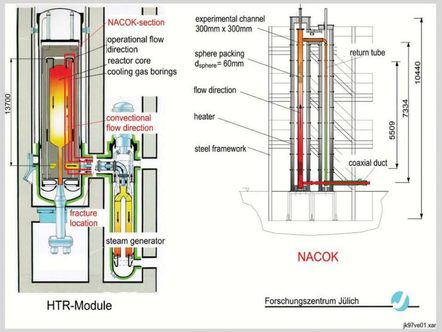
Cooperative Agreement Massachusetts Institute of Technology (MIT)

The NRC and MIT cooperative agreement includes the following scope and benefits:

- ▪Support NRC in assessing innovations in nuclear technology to maintain up to date, state of the art knowledge in nuclear technology.
- ▪Increase the knowledge and tools available to NRC as it addresses future reactor regulations.
- ▪Enhance communication between the NRC and MIT about specific research activities in particular areas of interest
  - ➢Typical areas of research:
    - •Fuel performance analysis for liquid metal cooled reactors
    - •Uncertainties in passive safety system performance
    - •Accident analysis involving air ingress in graphite moderated reactors.







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